


Chapter 2 The Electromagnetic Spectrum

A close-up photograph of a young man with dark hair, smiling and holding a silver flip phone to his ear. He is wearing a light blue button-down shirt. The background is dark with some out-of-focus light spots.

In 1987 there were just 100 000 cellphones in Canada. By 2001, there were over 9.5 million. Some experts estimate that by the year 2010 there will be over 2.2 billion cellphone users worldwide. Teenagers make up the fastest growing segment of the market in Canada. Recent statistics indicate that a typical Canadian teenager with a cellphone sends or receives more than nine text messages and makes at least three phone calls a day.

Many people are surprised to learn that a cellphone is actually a transmitter and receiver of radio waves. Radio waves are used in communications and broadcasting and in microwave ovens to heat food. Radio waves emitted by objects in space are collected by astronomers using very large radio telescopes. These radio waves provide valuable information about solar flares, sun spots, and the surface temperatures of planets.

How are the radio waves sent and received by cellphones different from the radio waves emitted from distant stars and planets? How are they the same? Why are the telescopes used to detect radio waves so much larger than the telescopes used to detect light waves? How do light waves compare to radio waves?

In this chapter you will have an opportunity to answer these questions as you explore the properties of radio waves, light, and the rest of the electromagnetic spectrum.

Try This Activity

Exploring Coded Signals

Background Information

Remote controls can be used to send commands to a large number of consumer electronics, such as televisions, VCRs, and DVD players. Nearly all remote controls use an invisible wave to send coded signals to the machine being controlled. When the waves containing the coded signal strike a photovoltaic cell, energy in the wave is transformed into electrical energy. If the photovoltaic cell is connected to a set of headphones, you can hear what the signal sounds like.

Purpose

In Part A you will compare the coded signals produced by different types of remote controls. In Part B you will explore some of the properties of the waves that carry these coded signals.

Part A: Listening to the Coded Signal

Materials

- photovoltaic cell with two leads
- 2 test leads with alligator clips at each end
- pair of sensitive headphones (the type you might use with a portable music player)
- at least two different remote controls, preferably with different brand names
- “Properties of the Waves Emitted by Remote Controls” handout

Procedure and Observations

step 1: Use the two test leads to connect the photovoltaic cells to the headphones, as shown in Figure C2.1.



Figure C2.1



Science Skills

- ✓ Performing and Recording
- ✓ Analyzing and Interpreting

step 2: Test the detector you built in step 1 by bringing it close to a strong light source and covering and uncovering the surface of the photovoltaic cell with your hand. You should be able to hear a wavering sound that corresponds to light intermittently hitting the surface.

step 3: Aim one of the remote controls at the photovoltaic cell. Press one of the keys and note the sound that is created as the coded signal strikes the photovoltaic cell. Test the other keys to see if you can hear differences in the sounds that relate to the corresponding signals. Record your observations.

step 4: Repeat step 3 for at least one other remote control that has a different brand name. Record your observations.

Part B: Properties of the Waves Emitted by Remote Controls

Procedure and Observations

step 1: Obtain the handout “Properties of the Waves Emitted by Remote Controls” from the Science 30 Textbook CD.



step 2: Follow the instructions on this handout, and record your observations.

Analysis

1. Suggest a reason why one brand of remote control is often unable to operate another brand of television.
2. Sketch a simple flowchart to show the energy transformations that occur from the batteries in the remote control to the sound you heard in your headphones.